GulfofMexicoSPU

Part I
Dispersed Plume Characterization Plan
Proof of Concept

6018993

Sub-Sea Dispersant Injection: Proof of Concept

I. Introduction and Background on Subsea Dispersant Injection

a. Overview

Prior to the Deepwater Horizon oil spill release, the impacts of the use of subsea dispersant injection on deep water spills have not been examined. BP has proposed this plan and is working within the Unified Command and within the depth, operational, and weather limitations presented during the response, to assess the feasibility, both operational and environmental, of using subsea dispersant injection as another response tool for combating this oil spill. It is thought that, if operationally and environmentally feasible, this tool could be considered in addition to other primary response strategies, such as mechanical retrieval, aerial dispersant applications, and in-situ burning.

Clearly, this unique strategy presents many unknowns. These include:

- The efficacy of dispersion in the subsea plume
- The size, location, movement, and dilution rate of a sub-surface plume which may occur if adequate mixing of the oil and dispersant occur at depth.
- The relative efficacy of subsea dispersant injection compared to aerial dispersant application.

b. Summary of subsea dispersant injection operations to date:

To date, two discrete injection attempts have been made to determine the operational feasibility of the strategy, to observe the aerial effect of the injection on the surface oil, and to capture preliminary physical and chemical data to characterize the dispersed oil at depth. These injections are discussed below.

Injection 1:

- Injection began at 17:31 and ceased at 22:31 on April 30, 2010.
- 2151 gallons of Corexit 9500 was applied during this test at roughly 9 GPM.
- Operationally successful: Operations was able to inject the dispersant into the plume at the source without complication.
- Qualitative observations of SONAR images taken before and after the dispersant injection indicate that the density of the plume, at depth, is diminished. These results are difficult to interpret given the unique application of the technology, which has not been calibrated.
- No samples were collected at depth or on the surface
- Aerial observations of the dispersed plume at the surface were not observed due to weather and visibility hindrances.

Injection 2:

- Injection began at 17:31 on May 2, 2010 and ceased around 23:00 on May 3, 2010. Injection was intermittent due to weather and operational issues.
- About 13,000 gallons of Corexit 9500 was applied during this test.
- Operationally successful
    - Collect samples of the non-dispersed oil and the dispersant/oil mixture at depth.
        - Of 4 samples, 2 misfired. Other 2 had very small amount of oil/water
        - Samples remained at depth until mid-day on 5/6
    - Observe the slick at the surface.
        - Aerial operations were shut-down during most of the injection due to weather.
- Operations proceeded without aerial observation, to:
    - Continue SONAR observations, and
    - Collect samples of the product to determine mixing efficacy of the dispersant at depth, as well as the physical and chemical properties of the dispersant injected plume.
- Intermittent pumping continued until 2300 Hrs on May 3, 2010
- Aerial overflights taken on May 4, 2010 revealed new “mental model” (discussed below) of dispersant/oil deep sea behavior

c. Hypothesis of the behavior of the oil when subsea dispersants are applied

The MMS and industry jointly funded and conducted an experiment off the Norwegian Coast where there was a controlled release of oil and natural gas in deep water. The data were used to calibrate spill models for deepwater blowouts. The oil was released in 864 m (~2600 feet) water depth. The oil reached the surface and was rapidly dispersed by prevailing winds and heavy seas. No damage to marine life was observed.

Best professional judgment and preliminary hydrodynamic modeling output predict that the dispersant will entrain with the oil as it travels to the surface (Attachment A). At this point, the amount or percent of mixing is unknown. Assuming that some amount of the dispersant is effective in dispersing some percentage of oil in the water, it is thought that the dispersant and small oil particles would create a “sub-surface plume” of dispersed oil that would eventually become neutrally buoyant in the water column. The depth at which this may occur could be as deep as 2500 ft (assuming median oil droplets of 50 microns) . The larger the oil droplets, the higher they will rise in the water column.

On May 4, 2010, skimmer operators reported difficulty skimming surface oil that spotter plans had directed them to based on the appearance of good concentrations of recoverable surface oil. That evening skimmer operators reported that it appeared as though the oil was "sliding" under the skimmer and disappearing on the other side without being retrieved by the skimmer. In addition, the sea state on May 4, 2010 was extremely calm (i.e., little to no wave energy). Given this information and aerial overflight photography taken on May 4, 2010, dispersant specialist, chemists, and physical scientists arrived at a hypothesis for this unusual oil behavior.

<u>New Mental Model</u>

It is now believed, based on the qualitative evidence discussed above, that the rate of dispersant and oil mixing in the water column is less than predicted. It is believed that some portion of the oil droplets and the dispersant rise together in the water column without mixing. The larger, non-dispersed oil droplets rise to the surface faster than the smaller dispersant particles. As a result, the oil arrives on the surface with a thin layer of dispersant distributed underneath it (Figure 1). Thus, without sufficient wave energy to aid dispersion, the slick would appear, by spotter plane, to be recoverable oil on the surface. Much as aerial dispersion would be ineffective without sufficient wave energy, so was this oil/dispersant mixture as it reached the surface.

So why couldn't the skimmers retrieve the surface oil? It is believed that the surfactant in the dispersant made the oil slippery as the skimmer attempted to pick it up. This would cause it to "slide" under the skimmer. In doing so, sufficient energy is created to trigger the dispersion.

This hypothesis is supported by the appearance of the oil observed by overflight on May 4, 2010. The red streamers of oil are consistent with the coloration typical of dispersing oil (Figure 2). It also appears that the ships on the water are aiding dispersion as the motors and dynamic positioning systems create mixing on the surface (Figure 3).

d. Implications for future deepsea injection use

BP recommends that the deepsea injection of dispersant into the oil plume be added to the "tool box" of current response strategies. Just as there are times when conditions are "ripe" for other response strategies, there are vital conditions under which the deepsea injection strategy can be employed to combat this oil slick. Most notably:

- **Weather**. Aerial applications cannot be used during bad weather or in the evening, thus limiting the window of opportunity. Subsea injection is not subject to these limitations and could be used as an effective response tool when other

- **Evening operations**. There are no other pro-active strategies that exist during the evening hours. Once daylight operations cease, oil continues to be released throughout the night. Subsea injection is not subject to this limitation and could be used as an effective response tool during the evening hours when other strategies are operationally impossible.

Subsea dispersant application proposed at 14,400 gallons/day (approx. 10 GPM) is thought to provide a more direct application of the dispersant into the oil than aerial application (totaling over 250,000 gallons to-date). Efficiency of aerial application is known to be affected by wind and potential over spray. It is believed that a large majority of the injected dispersant entrains in the oil plume and travels through the water column along the same trajectory as the oil; thus, maximizing its efficiency.

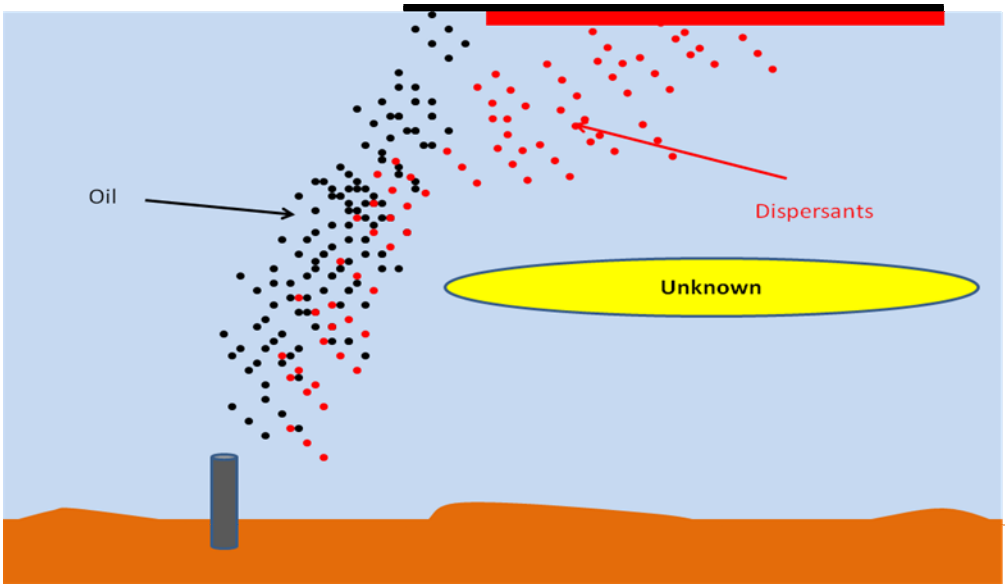


Figure 1: Simplified illustration of hypothesized of oil and dispersant behavior during calm sea conditions.

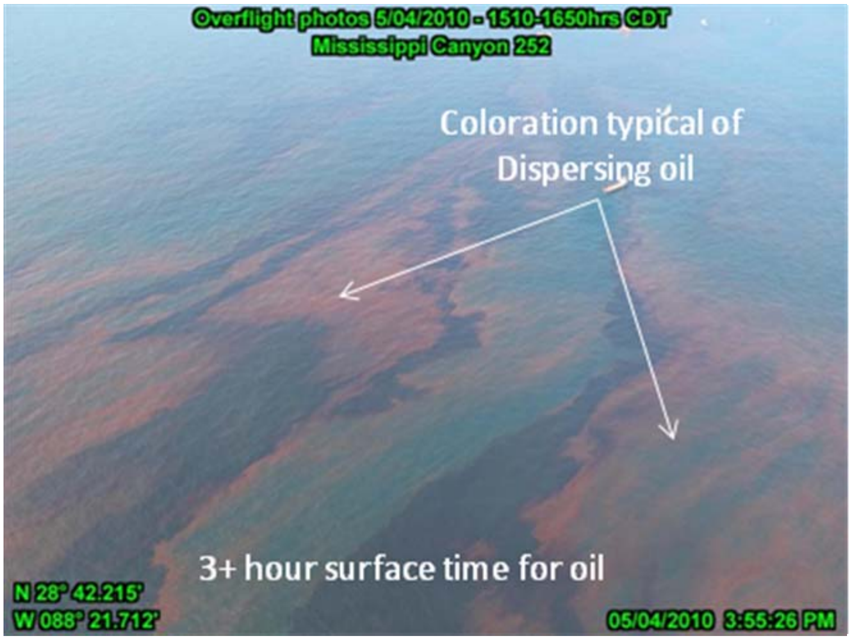


Figure 2: Representative aerial photograph of surface dispersion from the subsea injection.

Figure 3: Example of dispersion from subsea injection taking place on the surface due to energy created by the dynamic positioning of the response vessel.

II. Monitoring Plan

a. Objective:

Use aerial and boat monitoring to determine if the subsea dispersant injection operation is chemically dispersing the oil plume.

b. Criteria for Effectiveness Determination

1) Change in character of surface oil slick
   a. reduction of surface oil footprint at surface; or
   b. reduction of oil slick thickness at surface
2) Presence of a shallow subsurface dispersed oil plume
   NOTE: The absence of a shallow dispersed oil plume does not necessarily indicate that the test has failed. It is possible that the plume is beneath the capability of the surface plume monitoring depth.

c. Sampling Area

Sampling will take place within 3 nm of the source. This range allows for the best opportunity to capture data related to the surfacing oil plume. It is essential that all in-situ burning or aerial dispersant applications cease in this location prior to data collection.

d. Prescribed Length of Time for Injection

It is recommended that the subsea dispersant injection last for 24 hours. This would maximize the window of opportunity for adequate sampling and aerial observation of the surface plume.

e. Data Collection

- Aerial observations and photographs as often as possible during Day 2 and Day 3 sampling period
  - Aerial monitoring on-board aircraft with trained observer.
- R/V Brooks-McCall to collect the following data hourly within a 3 nm radius of the surfacing source location:
  - Fluorometry data ranging from 1 to 10 meters, as instrumentation permits
  - Conductivity, Temperature, Depth (CTD)

  - Dissolved oxygen
  - LISST (Particle size analysis)
  - Water samples (for hydrocarbon analysis). These samples will be stored in ice at 4 degrees Celsius for no more than 48 hours.
- Sampling locations will be based on the most recent reports of the spatial extent of the surface plume.
- Data results and interpretation delivered to Area Command Environmental Unit:
  - Raw data
  - Graph of results
  - Aerial Photography
  - Interpretations, as needed
- Regional Response Team (RRT) will receive all collected data within 24 hours after the monitoring period ends. *

* Due to laboratory, it will not be possible to provide hydrocarbon analysis within this 24 hour timeframe.

f. Recommended Schedule

This schedule (Figure 1) is recommended in order to achieve maximum flushing of potential aerial dispersants from the sampling area while maximizing continuity of operations.

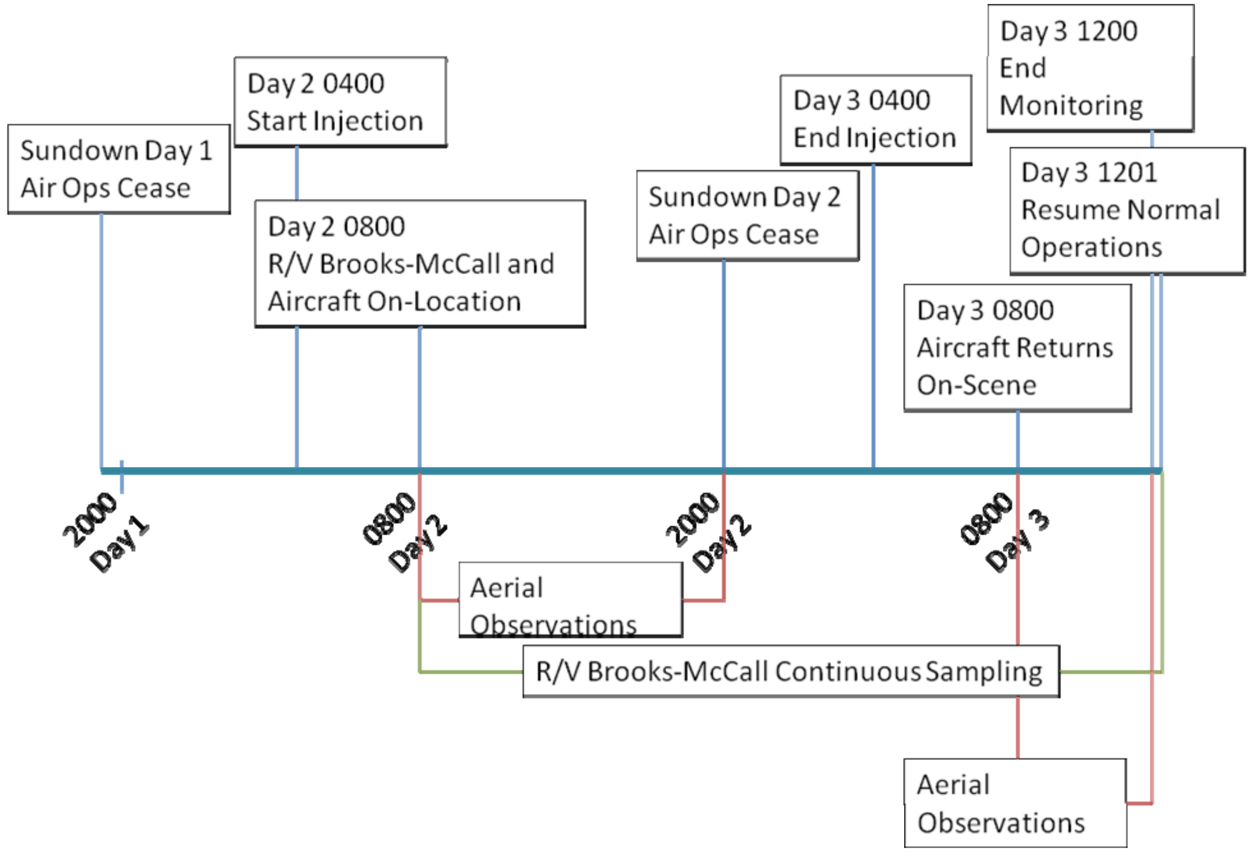


Figure 1: Proposed Timeline for Subsea Injection Proof of Concept Sampling Implementation.

g. Operational Restrictions within Test Area

- No aerial dispersant operations within 3 nm of source until monitoring ceases (Day 3 at 1200)

h. Next Steps

Pending the review of the Proof of Concept data results by the RRT, it is recommended that the RRT approve continued use of the subsea dispersant strategy as an additional response tool for implementation under favorable conditions (as described in Section I).

III. Communications Plan for Proof of Concept Monitoring

This plan outlines basic communications protocols for Subsea Dispersant Injection, Proof of Concept.

a. Objective

To ensure clear communication from field operations of Subsea Dispersant Injection, Proof of Concept

b. Communications

Accountable Persons: FOSC and BP AC
Communication Route:
ROV Vessel:

ROV Vessel Operator ←→ Operations SC ←→ BP AC ←→ FOSC

Air Operations:

Air Operations SC ←→ BP AC ←→ FOSC

R/V Brooks-McCall

R/V Comms. Coord. ←→ AC EU ←→ FOSC

Communication Frequency: At a minimum, as prescribed below, then as necessary.

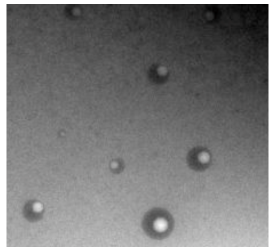
Communication Parameters:

Communication	Expected Time	Reported To	Reported From	Actual Time
Notification Injection Start		FOSC	ROV Operator	
Pump Rate	Record Hourly			
Cumulative Volume Pumped at Hourly Notification	Record Hourly			
Monitoring Video - Status	Check Hourly			
Visual documentation of dispersed plume in water column via ROV	Check Hourly			

Air Ops Deployed		FOSC	Air Ops SC	
R/V on-scene		FOSC	Crew Chief	
Notification Injection Stop		FOSC	ROV Operator	
Total Volume of dispersant pumped	End of Test	FOSC	ROV Operator	
Brief Air Ops: “no aerial dispersant operation within 3 nm of source until monitoring ceases	Morning Air ops			
Brief On-water Ops: “surface response operations must coordinate with monitoring effort to ensure collection of required data”	Morning surface ops			
Confirmation aircraft is airborne and enroute		FOSC	Air Ops SC	
Confirmation R/V is enroute		FOSC	Comms. Coord.	
Confirmation that R/V and aircraft are on-scene and initiating data collection		FOSC	Airs Ops SC and Comms Coord	
Deliver pump log to AC Env Unit		FOSC	ROV Operator	
Confirmation that all monitoring is concluded.		FOSC	Airs Ops SC and Comms Coord	
RTB notification from aerial overflights		FOSC	Airs Ops SC	
Verbal report from aerial regarding visual observation		FOSC, or as designated	Aerial Observer	
RTB notification from R/V		FOSC	Comms. Coord.	
Initial R/V fluoremetry data analysis begins		FOSC, or as designated	Comms. Coord.	

Delivery of data results to AC Env Unit		AC EU	Aerial observer and R/V Chief Scientist	

Attachment A



Dispersant injection at the source

BACKGROUND

Preliminary indications are that the dispersant injection is successfully creating an oil–dispersant mixture. While operations at this depth have never been undertaken, some educated speculation about terminal droplet size can be done using results from experiments done at Warren Springs Lab. The Lab conducted field trials on premixed oil-dispersant in a series of field trials over a wide range of environmental conditions. Their results:

Similar droplet sizes occurred for varying environmental conditions
Median droplet size (by volume) was 50 microns

NRL Gliders

Naval Research Lab is investigating the possibility of providing the sampling team with subsurface gliders equipped with some method for detecting hydrocarbons (presumably some kind of fluorescence) Point of contact is Captain George Cox, mobile(334 538 9842).

CDOG MODEL OUTPUT

The Clarkson University model, CDOG, presumes that the oil-gas mixture the plume maintains its rough integrity for approximately the first 300 meters. After this the plume loses its integrity and becomes a series of buoyant droplets. According to the model, the actual hydrocarbon density in the water column drops off considerably as one moves away from the source. Figure 1 shows the expected oil density at 4 hours and at 30 hours after injection, assuming 20% efficiency of the dispersant application. The distances are from the release point. Please note that for display purposes the vertical and horizontal scales are different. While the air-water surface remains a collection point, Water column concentrations are expected to be below 1ppm at depths less than 800 m, except directly above the source. The actual concentration in the top mixed layer may be higher due to surface oil being driven back into the water column. If we assume that the dispersant is more successful (70%), then the oil concentrations in the water column are increased.

These profiles were generated using NOAA forecasted currents that will be different for subsequent days of operations. However, the general dispersion characteristics are not expected to change, only the general headings of the plume. Actual plume forecasts can be done for any continuing operations and monitoring program

Figure1: Concentration profile with 20% dispersant at 4 hrs

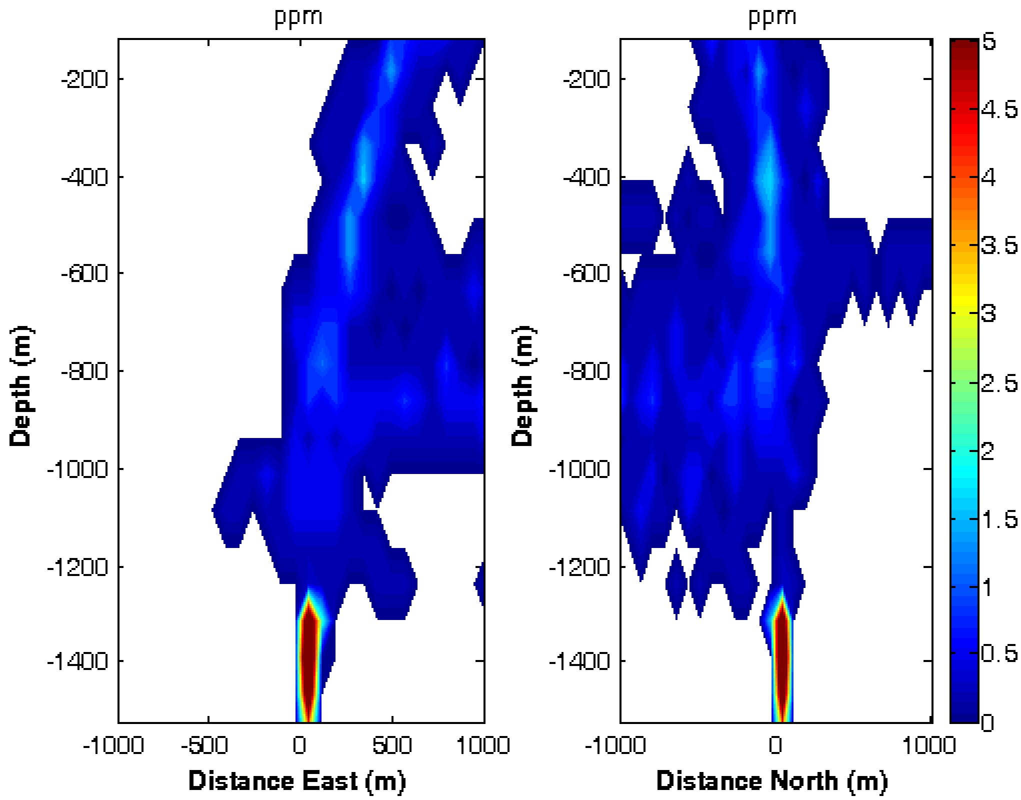


Figure 2: Concentration profile with 20% dispersant at 30hrs

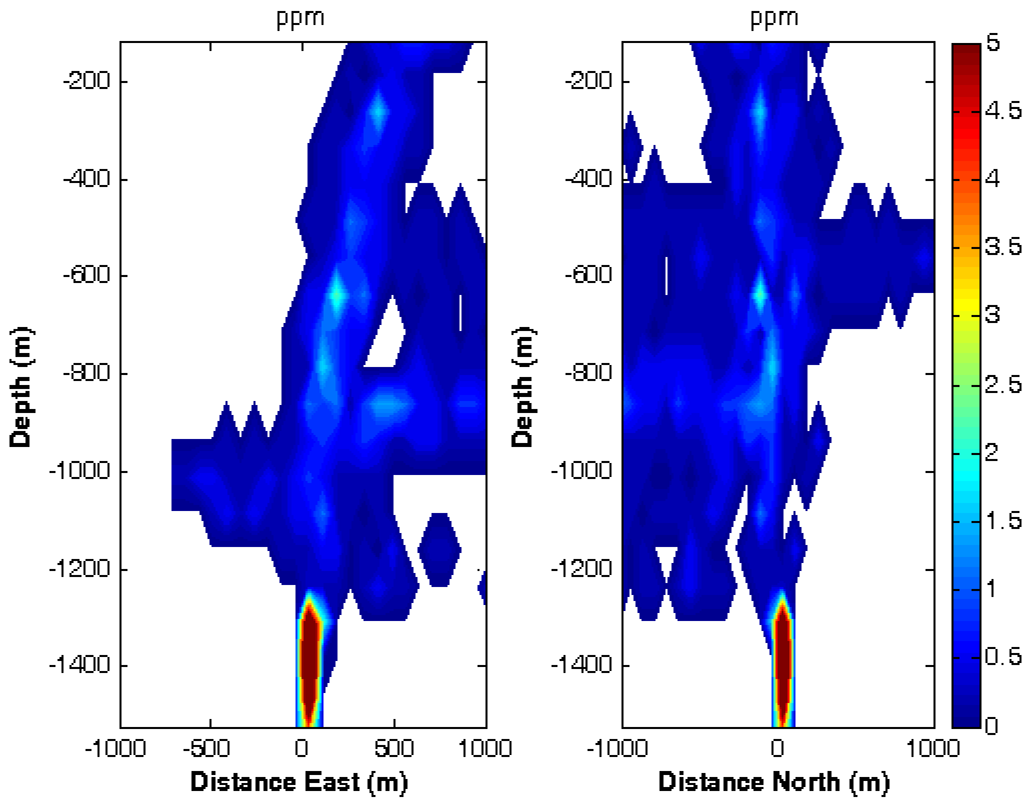


Figure3: Concentration profile with 20% dispersant at 72 hrs.

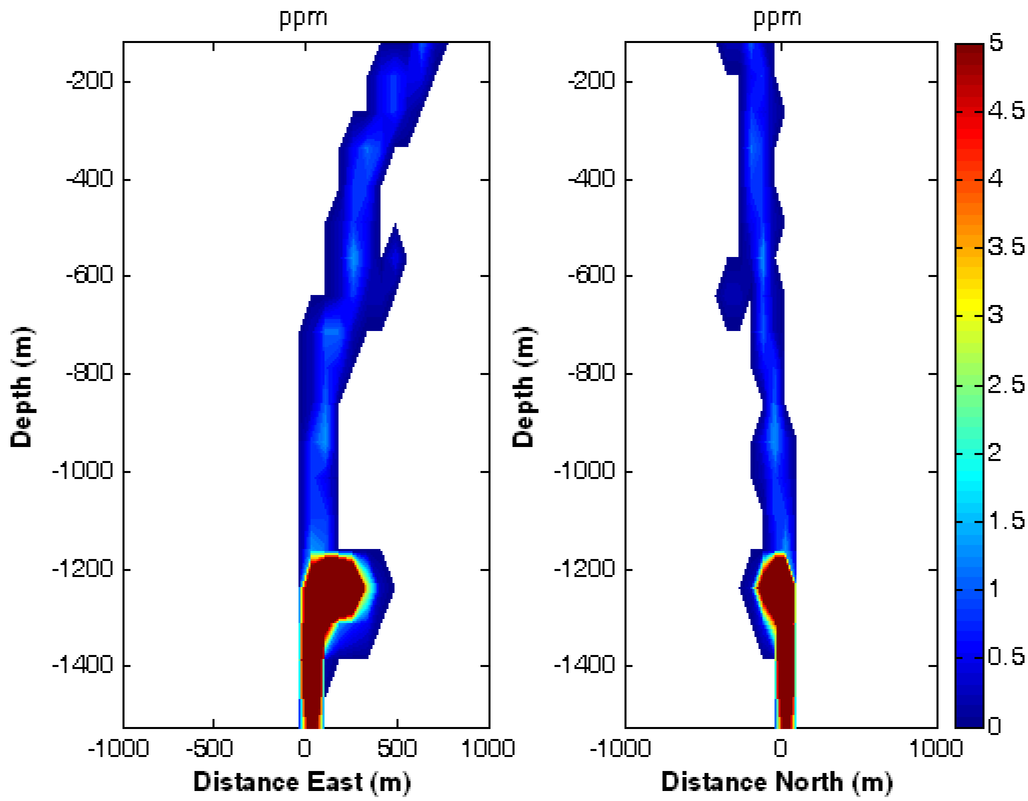


Figure 4: Concentration profile with 70% dispersant at 4 hrs

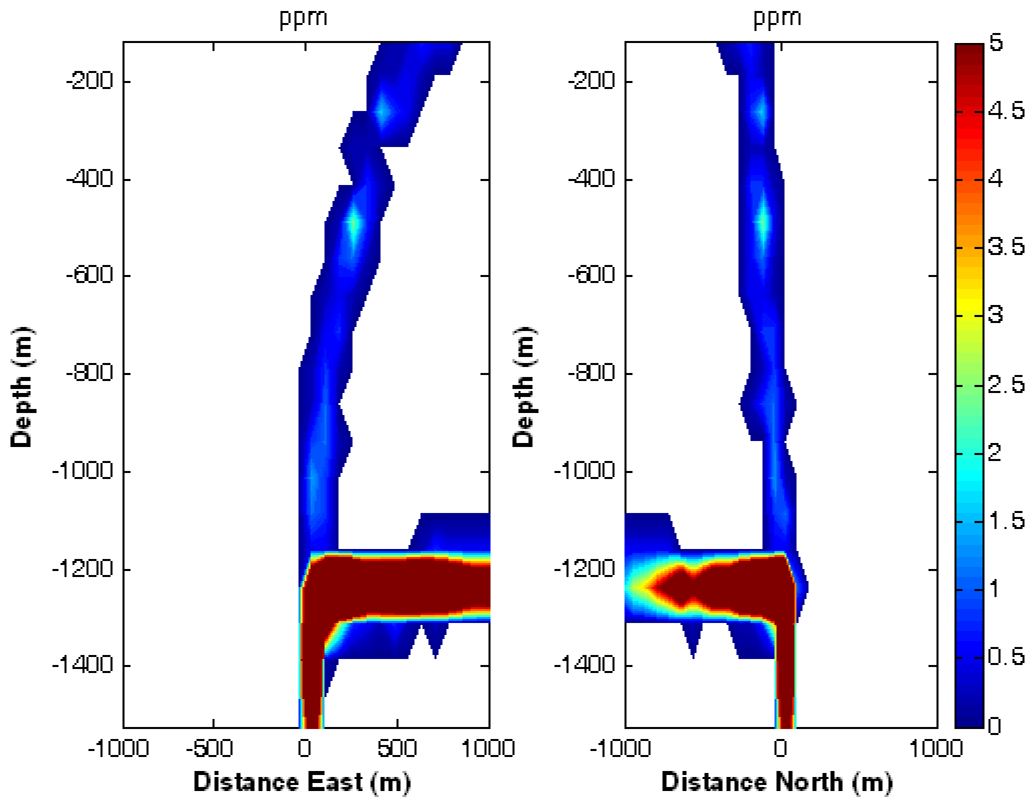


Figure 5: Concentration profile with 70% dispersant at 30hrs

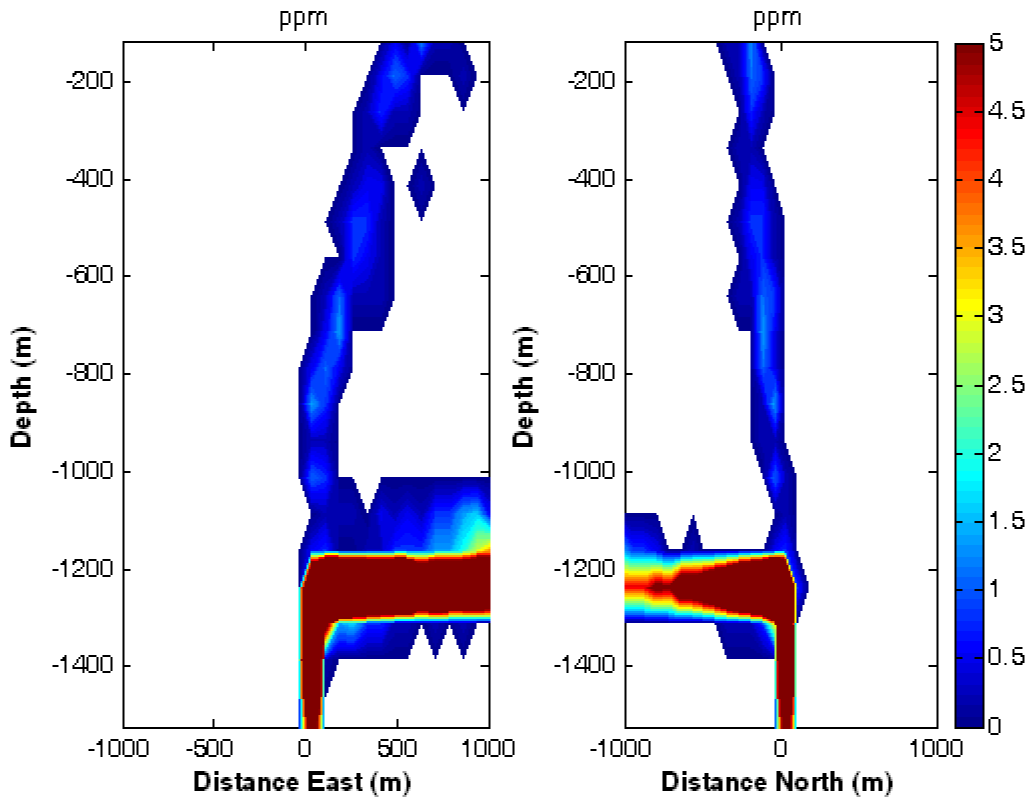


Figure 6: Concentration profile with 70% dispersant at 72 hrs

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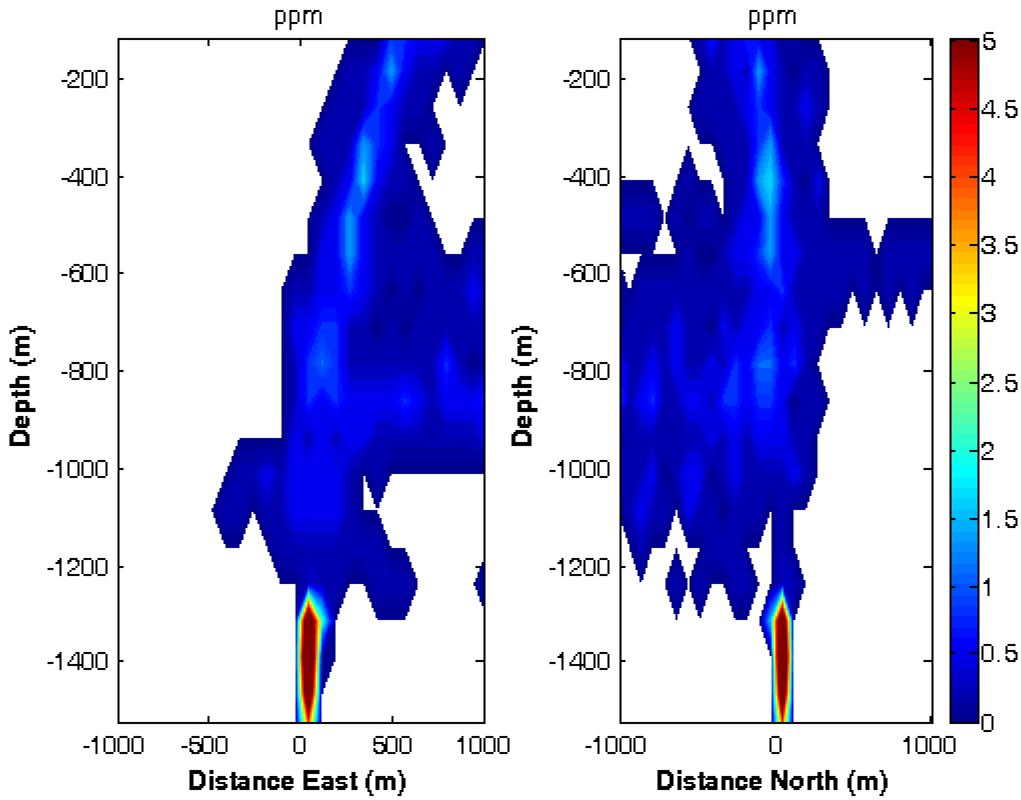

ppm
ppm
Depth (m)
Depth (m)
-200
-400
-600
-800
-1000
-1200
-1400
-1000
-500
0
500
1000
Distance East (m)
-1000
0
1000
Distance North (m)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0

GulfofMexicoSPU

Part II

Dispersed Plume Characterization Plan

Table of Contents

I. Project Objectives

This Dispersed Plume Characterization Plan will be implemented (via the Subsea Injection of Oil Dispersant Plan) once the Proof of Concept test is complete, the data is analyzed, and a determination is made on the effectiveness of deepsea dispersant injection.

Dispersed plume monitoring will determine chemical and physical characteristics of the dispersed plume concentration and inform hydrodynamic transport models. The data collected during this field project will directly support the operational “shut-down” determination for deepsea dispersant injection, as requested by EPA.

This plan is not intended to serve as a Natural Resource Damage Assessment (NRDA) on this Incident. A NRDA will be undertaken by the natural resource trustees.

II. Monitoring Plan

A. Timing

The dispersed plume characterization and monitoring will begin when necessary equipment is procured, the R/V Brooks McCall is on location and outfitted, a crew is identified, and this plan is finalized.

B. Monitoring Objectives

1. Confirm location and extent of the subsurface plume.
2. Determine how much oil (total PAH) remains in the dispersed plume.
3. Collect physical oceanographic data to validate the sub-surface dispersed plume model.

C. Overview of Methodology

This field survey and monitoring plan has been adapted from the EPA recommendations provided to the Area Command on 6 May 2010 . Every effort has been made to incorporate this methodology to the extent practical, given shipboard conditions.

1. Detection and delineation of dispersed plume

a. Fluorometer (cast, not towed): Utilize a CDOM Fluorometer configured with Excitation wavelength (Ex) of 370 nm and Emission wavelength (Em) of 460 nm to delineate horizontal and vertical extent of subsurface plume. The fluorometer will be cast at locations based on the dispersed plume model and other real-time information that can direct the monitoring operation. The fluorometer will sample from surface to 5000 feet and will be cable-integrated with the Sea Bird 19 Plus CTD unit that is currently on the Brooks McCall. CDOM fluorometer measurements will be merged with and stored within the Sea Bird 19 Plus CTD.
b. LISST-ST: Utilize a LISST-ST Particle Size Analyzer to delineate horizontal and vertical extent of subsurface plume and to validate the dispersed plume hydrodynamic model. The LISST-ST analyzer will be cast at various locations of the affected area. Survey points will be co-located with fluorometry monitoring, when feasible.
c. UV-Fluorescence: Water samples will be collected for use in shipboard UV-fluorescence to provide real-time characterization of chemically versus naturally dispersed oil in the water column. Attachment C provides background information on the rationale for this detection method.
d. Rototox: A rapid 24-hour acute toxicity assessment kit using the marine rotifer *Brachionus plicatilis* will be conducted on the ship. Note that all toxicity tests are very difficult to perform shipboard. The Rototox-M Standard Operating Procedure (SOP) will be followed, with any modifications required to adapt to shipboard conditions. This SOP accounts for triplication of samples for statistical purposes.

2. Water column sampling collection

Samples will be taken at varying depths using a rosette sampler or similar collection device that can collect multiple samples at various depths and collect large enough samples for the following purposes. When appropriate, pressurized water samples will be collected according to reference ASTM Publication No. 148-1 and USGS Water Supply paper No. 1454. All water samples will be collected in at least 1 Liter volume following the Sampling Quality Control Plan in Section VII.

a. Total PAH analysis. These samples will be transported to BP-approved and accredited laboratory.
b. Dissolved oxygen: Verification of potential DO depletion in the plume will be monitored in collected water samples by means of i) shipboard dissolved oxygen Winkler kits and ii) dissolved oxygen probes. *Note that a full Winkler titration system would be difficult to operate on this vessel, since very precise titration would be difficult to achieve shipboard. The Winkler test kit, which utilizes the same reagents, is designed to be effectively used in field conditions.*

Water column sampling will be conducted in a manner consistent with the Entrix *Water Quality Profiling Service* plan.

3. Physical oceanographic data collection

a. CTD: Initial Conductivity Temperature and Depth (CTD) will be conducted to determine water column stratification or other physical oceanographic parameters that will help determine depth of samples collected and further validate the model.
b. Currents: Numerous Acoustic Current Doppler Profilers (ACDP) units are deployed throughout the area of interest. Data will be applied to this monitoring effort, as appropriate.

III. Cruise Plan

A. Vessel Information

Vessel Name: R/V Brooks McCall
Departure Port: Fourchon, LA
Departure Date: 8 May (Friday) 2010; 00 hours (est.)
Length of cruise: 7-30 days, depending on findings

B. Scientific Crew

<table>
<tr><th colspan="4">Operational Research Team</th></tr>
<tr><th>Name</th><th>Organization</th><th>Role</th><th>Cell Phone</th></tr>
<tr><td>Don Aurand, Ph.D.</td><td>EM&A, Inc., for BP</td><td>Chief Scientist</td><td>703-431-7082</td></tr>
<tr><td>Ben Shorr</td><td>NOAA</td><td>Data Management Coordinator</td><td>206-280-5336</td></tr>
<tr><td>Jennifer Cragan</td><td>ASA, for NOAA</td><td>Sampling Technician</td><td>401-316-5600</td></tr>
<tr><td>Blake Schaeffer, Ph.D.</td><td>EPA</td><td>Communications Coordinator</td><td>850-418-4570</td></tr>
<tr><td>Robyn Conmy, Ph.D.</td><td>EPA</td><td>Toxicity Testing</td><td></td></tr>
<tr><td>Ken Lee, Ph.D.</td><td>Fisheries and Oceans Canada (for EPA)</td><td>Particle Size Testing</td><td>902-426-7344</td></tr>
<tr><td>Zhengkai Li, Ph.D</td><td>Fisheries and Oceans Canada (for EPA)</td><td>Particle Size Testing</td><td>902-426-3442</td></tr>
<tr><td>Paul Kepkay, Ph.D.</td><td>Fisheries and Oceans Canada (for EPA)</td><td>U/V Spectrofluorometry</td><td>902-426-7256</td></tr>
<tr><td>John Williams</td><td>Entrix, for BP</td><td>Sampling Technician</td><td>361-648-3950</td></tr>
<tr><td>Andrew McQueen</td><td>Entrix, for BP</td><td>Sampling Technician</td><td>832-407-2628</td></tr>
<tr><td>Mike Caravello</td><td>BP</td><td>Industrial Hygienist</td><td>732-489-2817</td></tr>
<tr><th colspan="4">Vessel Crew (in support of research team)</th></tr>
<tr><td>James Howell</td><td rowspan="7">TDI Brooks</td><td>Party Chief</td><td rowspan="7">281-794-3806 (Party Chief)</td></tr>
<tr><td></td><td>CTD Operator</td></tr>
<tr><td></td><td>Winch Operator</td></tr>
<tr><td></td><td>Winch Operator</td></tr>
<tr><td></td><td>Navigator</td></tr>
<tr><td></td><td>Navigator</td></tr>
<tr><td></td><td>Electronics Technician</td></tr>
</table>

C. Sampling Grid

The initial grid pattern will be based on the most recent modeling results of the spatial extent and location of the plume. The current plume model suggests that a 1km spacing would be appropriate for initial location of the plume. Once the plume is located the grid pattern will be refined to a sample density adequate to delineate the plume boundaries.

Information collected at the sample locations will be used to iteratively refine the sampling grid, as well as to provide the hydrodynamic plume transport model with real time input data. These data include:

- Fluorometry results
- CTD cast results
- Local current information from ADCP onboard other vessels

The first phase of sampling will determine the factors needed to calculate dispersion effectiveness, namely, % oil, % water, % dispersant. This phase of sampling should determine the factors to predict buoyancy; namely bubble sizes, density (or specific gravity) along the thermal gradient of the water column, and kinematic viscosity.

D. Coordination of Testing Activities

This is an adaptive Cruise Plan requiring onboard decision-making based on real-time data analysis. The ultimate responsibility for data acquisition and prioritization of testing will rest with the BP Chief Scientist, Dr. Don Aurand, in consultation with BP and the Environmental Unit at Area Command.

IV. Communications Plan

This section outlines the basic communications event schedule for the Dispersed Plume Monitoring Cruise. The objective is to ensure clear communication between the vessel and the Area Command Environmental Unit.

A. Responsibility for Transfer of Scientific Data

Research Vessel: BP Chief Scientist, Dr. Don Aurand
Area Command Environmental Unit: BP Environmental Consultant, Dr. Gina Coelho (or other BP designee, when relieved)

B. Summary of Scheduled Communication Events:

Events	Scheduled Time	Frequency	Initiator	Recipient
Daily Situation Update	0730	Daily	AC Env. Unit	Vessel
Daily Activity Summary	2000	Daily	Vessel	AC Env. Unit
Significant Event Report	As Req.	As Req.	Either	Either
Data Collection Log	2100	Daily	Vessel	AC Env. Unit
Start of Sampling	-	-	Vessel	AC Env. Unit
Cessation of Sampling	-	-	Vessel	AC Env. Unit
Modeling Data Update	1200, 1800	Daily	Vessel	AC Env. Unit
Special Requests	0700, 1200	As Req.	Either	Either

C. Communication Protocols

Direct communication with the vessel concerning the monitoring program is limited to the AC Environmental Unit. The contact for scientific information and coordination is:

Dr. Gina Coelho (Scientific cruise coordination - AC Environmental Unit)

- Cell phone: 410-474-0633 (subject to change with staffing changes)
- Sharing all daily reports with the AC Environmental Unit representatives
- Coordinating all questions or requests for information related to the vessel research mission
- Integrating any changes to the original monitoring objectives into this adaptive cruise plan
- Coordinating transfer of samples to an approved laboratory for analysis

The contact for operational information and coordination is:

Dr. Al Maki (Simultaneous Operations (SIMOP) - Houma ICP)

- Cell phone: 307-654-7135 (subject to change with staffing changes)
- Ensuring the research vessel operations are integrated into daily on-water operations briefs
- Ensuring the research vessel Captain is updated daily with operational activities that will impact the research mission, including communication channels, NOTMARs, etc.
- Coordinating transfer of samples from the research vessel to shore via support boats
- Coordinating transfer of additional equipment to the vessel via support boats

V. Data Management Plan

A. Sample Data

Data that is collected ship-board will be received in electronic (ideally spreadsheet, possibly graphic) or paper format and incorporated into a field sampling database. All laboratory chemical analysis that is performed on collected water samples (PAH Analysis) will be received in digital spreadsheet format and incorporated into the field sampling database.

B. Sample Locations

Coordinates for all sampling efforts (observations, physical data and chemical analysis) will be recorded and managed with unique Station ID's. Latitude and Longitude will be recorded using Differential GPS (DGPS) with horizontal datum NAD83. Vertical location of samples will be recorded as depth below water surface and will be corrected to NAVD88 and MLLW.

Physical sample data collected as part of this effort includes fluorometer analysis, particle size analysis, UV-fluorescence, conductivity, temperature, depth and dissolved oxygen. Data from Acoustic Current Doppler Profilers (ACDPs) will be gathered from multiple sources. Atmospheric and oceanographic data from multiple proximate buoys including wind speed, atmospheric pressure, air temperature and water temperature from NOAA's National Data Buoy Center (NDBC) will be gathered and incorporated into the field database.

Chemical data involves Total PAH analysis at a BP-approved environmental laboratory. The Modified EPA Method 8270 will be used because the list of PAHs is expanded to include the alkylated homologs, using GC/MS in the selected ion monitoring (SIM) mode. Detection levels should be 1 ppb for individual PAHs.

VI. Subsurface Injection Shut-down Criteria

This section discusses criteria under which operational shut-down of deep sea dispersant injections would occur. The following criteria have been developed by EPA. These criteria would only be used when the presence of elevated levels of hydrocarbons is indicated based on fluorometry data.

A. Non-Biological Monitoring Assay for Operational Shutdown Decision

EPA suggest measurement of oxygen concentrations within the dispersed oil plume be used as one of the criteria for stopping operational subsurface dispersant application. Historically, such concentrations have averaged about 4 mg/L based on extensive historical oceanographic measurements. DO probe readings will be performed in the field and values relayed to Area Command. If there is a confirmed statistical reduction in DO of 2 mg/L relative to background, discussions will take place to determine whether subsurface dispersant injection operations should be shut down. Statistical significance of DO concentration reduction is defined by three repeated results at a single station.

B. Biological Monitoring Assays Needed for Operational Shutdown Decisions

Various techniques can be used to determine if the underwater dispersant injection is producing toxic responses in the biota sufficient to recommend shutting down the operation. A Rotoxkit assay to estimate the acute toxicity to the marine rotifer, *Brachionus plicatilis,* has been identified as the biological indicator for operational shut-down. This is rapid field test kit giving LC50 results in 24 hours. If an 80% change in the background LC50 in a triplicated test is observed, discussions will take place to determine whether subsurface dispersant injection operations should be shut down.

VII. Data Quality / Sampling Quality Control Plan

This section provides guidance for data quality assurance for the collection of field samples and data collection. All data collection shall be recorded in a bound laboratory notebook with numbered pages, per General Laboratory Practices. Data or log entry errors will be stricken with a single line, following General Laboratory Practices, and will be initialed by the person making the correction.

Collection of all water samples will be adequately documented to include sample number, GPS location, data, time, depth taken, and initials of sampler. The CTD triggering sequence shall be verified and documented at each sample collection station in order to verify samples were collected as expected. The sample number and sampling station shall be recorded on the Laboratory Management Program (LaMP) *"Project Information Form" and "Chain of Custody Record"* form, both which have been made available to the science crew via Excel spreadsheet. Water samples that are not being analyzed onboard will be immediately stored (in I-Chem bottles) in an ice chest in order to maintain a targeted temperature of 4 °C (+/- 0.5 °C). Samples should not be frozen. A thermometer will be available to remain with the aqueous samples in storage for monitoring purposes. Samples will not be acidified, so they will be transferred to shore within 72 hours of collection for transport to the chemistry laboratory.

All water sample and data collection equipment should be visually inspected before sampling. Decontamination or replacement of equipment should occur when fouling of equipment is noted. Any malfunction of data collection equipment or onboard testing shall be clearly documented. The CTD undergoes an annual factory calibration.
The O_2 sensors and fluorescence sensors come with calibration certificates and the O_2 sensor will be cross checked against water samples that are analyzed with the onboard DO probe and DO test kits. All equipment will be operated in accordance with manufacturer recommendations.

Any onboard QA/QC issues will be resolved through the onboard BP Chief Scientist in consultation with BPs POC for Laboratory Quality Control:

Rock J. Vitale, CEAC, CPC
Consulting Chemistry
Environmental Standards, Inc.
Cell phone: 610-304-9972

VIII. Shipboard Safety

A safety briefing and ship orientation will be provided to the full scientific crew immediately after check-in. This safety briefing will cover all standard R/V Brooks McCall vessel, safety and medical emergency protocols. Each crew member shall sign verification that they have received the training before commencement of operations. In addition, each crew member will complete an Emergency Notification Form.

The shipboard BP Industrial Hygienist (IH) will review all Material Safety Data Sheets for hazardous materials used onboard and ensure that appropriate safety protocols are being observed. In addition the IH will monitor health and safety issues for the duration of the cruise to ensure the safety of the team. The IH has the authority to put additional safety protocols in place as the need arises.

Attachment A
Acknowledgement of Safety Training and Emergency Contact Information

Your Name	Signature to Verify Receipt of Safety Training	Emergency Contact Information			
		Name	Relation to You	Phone	Alternate Phone

Attachment B
Adaptive Monitoring Plan – Change Tracking Form

Date	Person Issuing Change	Description of Change	Rationale for Change

Attachment C
Background Provided by EPA on 2D UV Fluorescence Spectroscopy (UVFS)

The fact that many organic compounds fluoresce at specific excitation and emission wavelengths is the basis for identifying many of the components of crude oil in seawater. When subject to excitation at 245-280 nm, polycyclic aromatic hydrocarbons (PAH) fluoresce over wavelengths of 310 to > 400 nm, depending on the number of aromatic rings in the structure. Only one group has examined the 2D UV Fluorescence Spectroscopy (UVFS) spectra of oil treated with chemical dispersants, the Ken Lee group at Fisheries and Oceans Canada (DFO). They found that a fixed excitation wavelength of 280 nm works best for fluorescence of PAHs in crude oil, and two different emission wavelengths, one at 340 nm for 1-and 2-ring PAHs and the other at 445 nm for 3-ring and higher PAHS, provide an excellent fingerprint for differentiating chemically dispersed oil from non-dispersed oil. As oil gets dispersed due to the action of a chemical dispersant, the peak height at 445 nm becomes highly pronounced relative to the peak height at 340 nm. Thus, computing the ratio of peak height at 340 to the peak height at 445 gives a direct measurement of the degree of dispersion that has taken place as a result of applying a dispersant to an oil.

The effect of oil dispersion on UVFS spectra can be expressed in terms of an emission ratio, so that dispersion can be tracked without having to measure oil concentration. The spectral changes associated with the application of dispersant can also be calibrated to quantify increasing oil or oil plus dispersant. The fact that UVFS and UVA data are comparable at an emission intensity of 445 nm or over the whole spectrum of intensities (from 300 - 500 nm) indicates that the fate of higher molecular weight (> 3-ring) PAH fractions - the more “dispersible” fraction of an oil slick - will provide a good idea of the fate of the oil as a whole during the dispersion process. Given that higher molecular weight PAHs may be associated with many of the persistent (or chronic) toxic effects of crude oils on marine organisms, the ability of UVFS to track “dispersible” fractions would make it a particularly useful tool in studies of the long-term toxic effects of dispersed oil.

GulfofMexicoSPU

2200 Drilling, Completions and Interventions

Part III

MC252 - Subsea Injection of Oil Dispersant

0	**05/08/2010**	**Approved - Issue for Use**	**Caleb Stevenson**	**Ricardo Tapia**
Rev	Date	Document Status	Custodian/Owner	Authority

Document Control Number	Organization ID	Sector ID	Discipline ID	Document Class	Sequence Number	Document Revision
	2200	**T2**	**DO**	**PR**	**####**	**0**

AMENDMENT RECORD

Amendment Date	Revision Number	Amender Initials	Amendment

TABLE OF CONTENTS

1 Subsea Injection of Oil Dispersant into the Cofferdam

This procedure outlines the steps that will be employed to implement injection of surface oil dispersant into the riser break oil plume.

1.1 Objectives

Perform Subsea Oil Dispersant Injection into the riser break oil plume using a coiled tubing supply line from the Subsea 7 vessel Skandi Neptune.

1.1.1 Materials List:

- Skandi Neptune with 2" coiled tubing down line-
- 42,000 gallons of Nalco COREXIT 9500 in 2 - 500 bbl storage tanks
- BJ Process and Pipeline pumping spread on board the Skandi Neptune
- 775 ft of flying lead to connect from the coiled tubing downline to the female 17H hot stab receptacle on the Cofferdam
- Riser injection wand with flying lead

1.1.2 Pre Job Needs:

- EPA Approval for use of surface dispersant in a subsea environment

1.1.3 Steps:

1. Establish position of the Skandi Neptune near the riser plume site in coordination with the Marine SIMOP's Plan.
2. ROV to survey route from coiled tubing end termination over to the riser plume site to check for debris which could harm the flying lead.
3. **CRITICAL NOTE: Start of Dispersant Injection MUST be authorized by the Deputy FOSC!**

If Injection will be done into one of the 4" Injection Ports on the Cofferdam:

1. Stretch out the 775' flying lead as required to reach the Cofferdam site.
2. Locate the nearest injection port site on the North, South or East side of the Cofferdam. The Cofferdam has no 4" port on its West side. See Section 1.1.4 for layouts of the Cofferdam with Injection Port locations identified.
3. ROV to plug in 17H hot stab in to the nearest 4" injection point on the Cofferdam. The 4" injection ports each have a 4" NPT X 17H hot stab adapter.
4. ROV to stand by and observe the hot stab while dispersant flow is established.
5. **CRITICAL NOTE: Start of Dispersant Injection MUST be authorized by the Deputy FOSC!**
6. Start up dispersant pumping from the BJ Services pumping equipment on the deck of the Skandi Neptune.
7. Establish a 10 gpm pumping rate into the Cofferdam.
8. Monitor the volume of dispersant pumped every hour and record.
9. If hot stab is stable in the receptacle the ROV can move to the top of the Cofferdam and observe the plume.
10. Adjust dispersant pumping rate when requested.
11. Shut Down dispersant pumping when directed.

If Dispersant Injection will be in to the 12" diameter chimney on top of the Cofferdam:

1. If the 4" NPT X 17H hot stab adapters are not available the dispersant injection will be done with the last version of the injection wand hung down into the 12" diameter chimney on the top of the Cofferdam. See Section 1.1.4 for layout drawings of the Cofferdam.
2. Perform ROV survey of the top of the Cofferdam to identify access and hold points for the ROV.
3. Insert wand with the injection quill pointed down into the 12" diameter chimney on the top of the Cofferdam and hold with the ROV to keep the wand from getting lifted out of the chimney by the plume.
4. ROV to stand by and hold the wand in place and observe the plume while dispersant flow is established.
5. **CRITICAL NOTE: Start of Dispersant Injection MUST be authorized by the Deputy FOSC!**
6. Start up dispersant pumping from the BJ Services pumping equipment on the deck of the Skandi Neptune.
7. Establish a 10 gpm pumping rate into the Cofferdam chimney.
8. Monitor the volume of dispersant pumped every hour and record.
9. Adjust dispersant pumping rate when requested.
10. Shut Down dispersant pumping when directed.
11. Switch to the primary procedure when the 4"NPt X 17H hot stab adapters for the Injection Ports are available.

If the Cofferdam is not available:

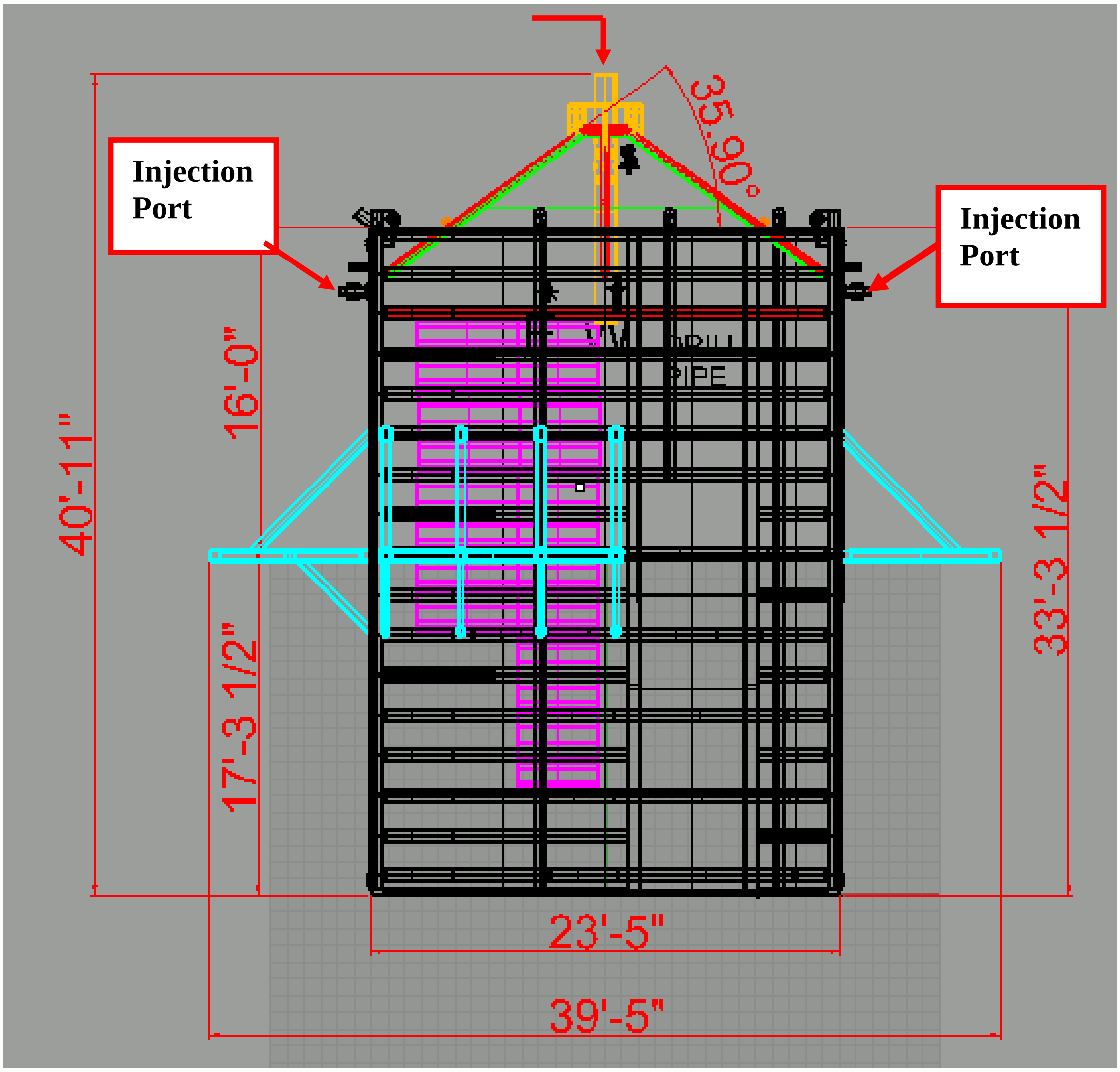
1. The last version of the Dispersant Injection wand from the second dispersant injection test will be used to inject dispersant into the plume rising from the end of the open riser pipe as done previously.

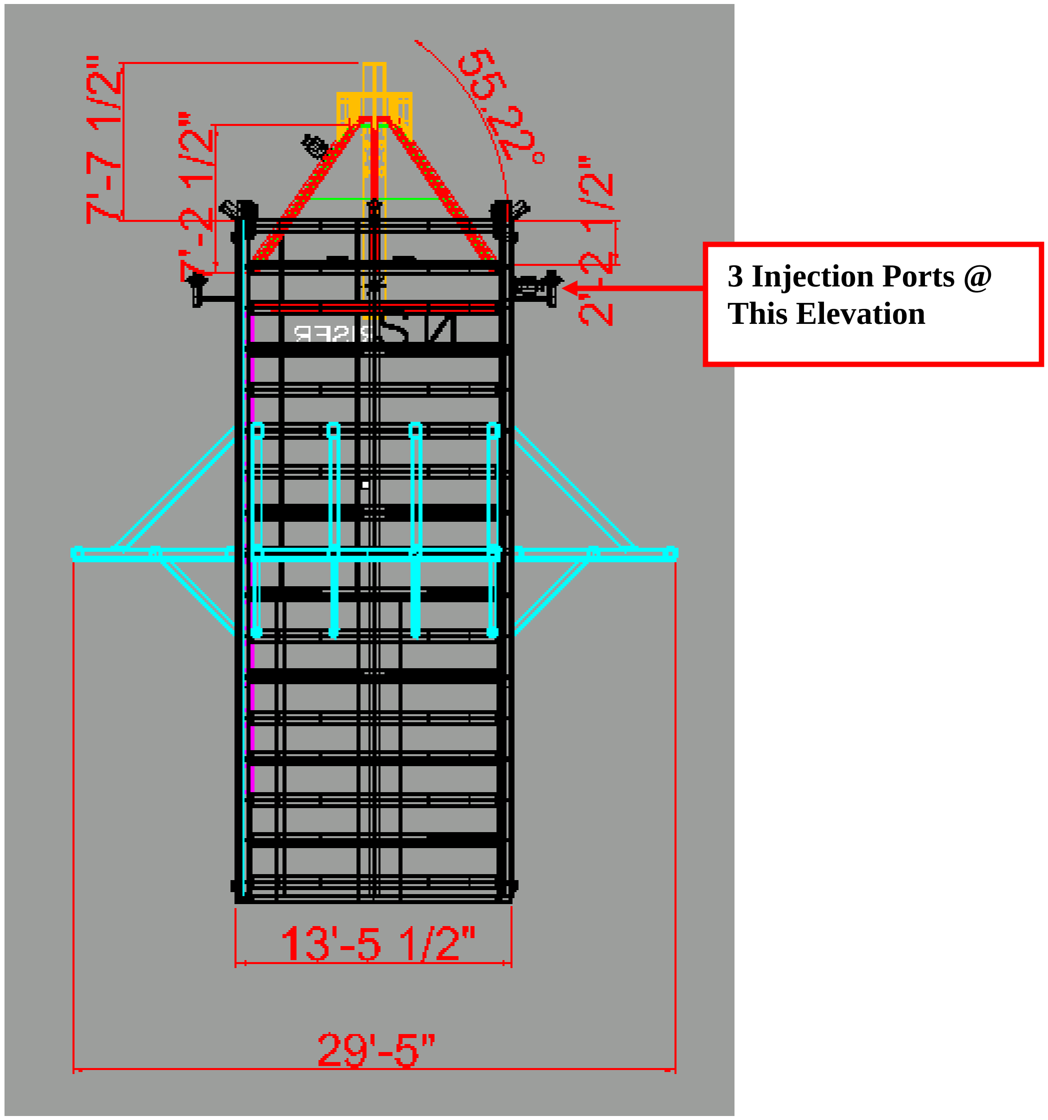
2. Use the ROV to insert the dispersant injection quill into the riser pipe opening where the oil plume is rising from the end of the pipe. Insert the quill into the pipe as far as possible.
3. ROV to stand by and hold the wand in place and observe the plume while dispersant flow is established.
4. **CRITICAL NOTE: Start of Dispersant Injection MUST be authorized by the Deputy FOSC!**
5. Start up dispersant pumping from the BJ Services pumping equipment on the deck of the Skandi Neptune.
6. Establish a 10 gpm pumpig rate into the injection quill.
7. Monitor the volume of dispersant pumped every hour and record.
8. Adjust dispersant pumping rate when requested.
9. Shut Down dispersant pumping when directed.

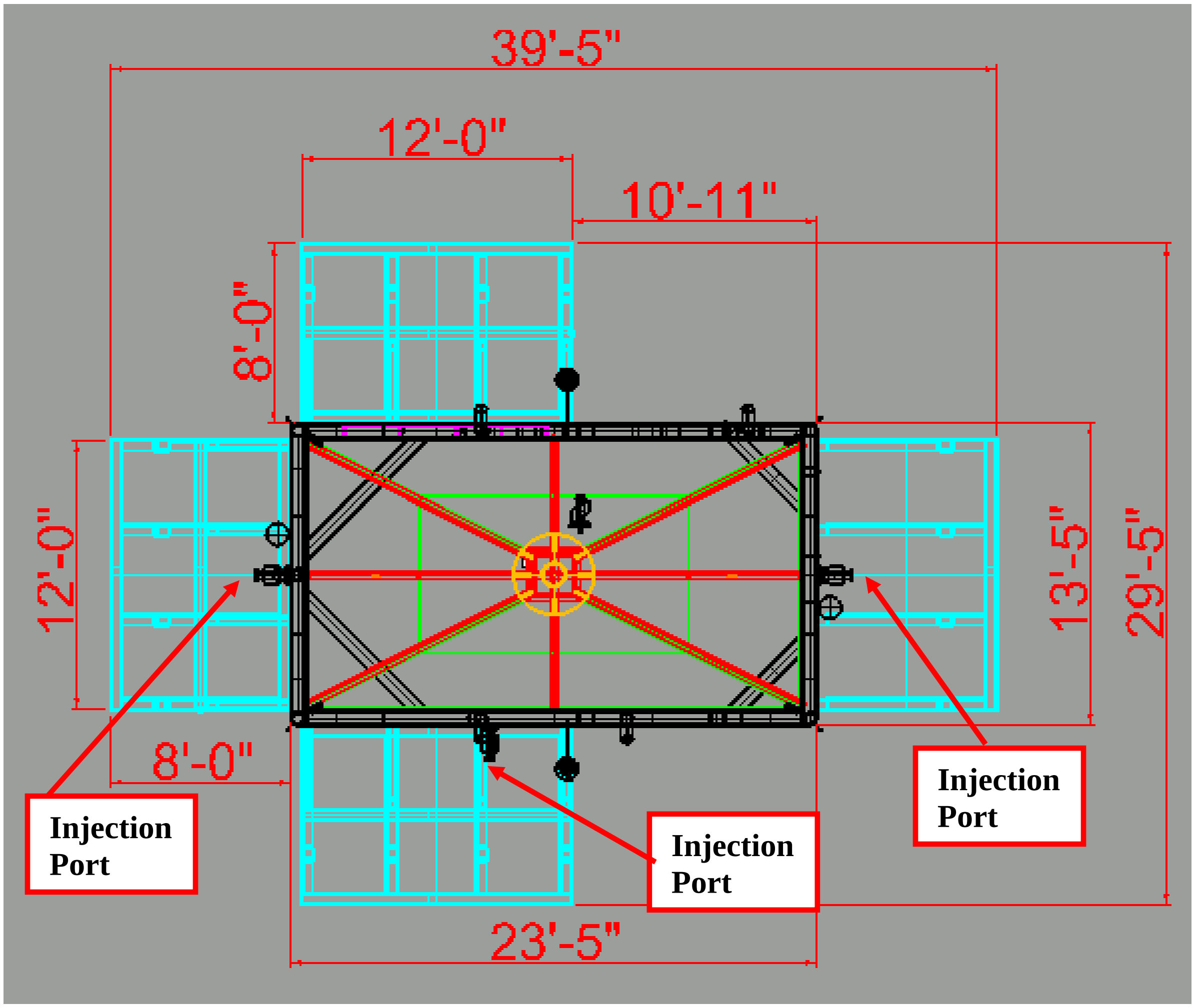
ROV Holding Dispersant Injection Wand with Quill Inserted Into The End of The Riser Pipe

1.1.4 Cofferdam Layouts:

12" Diameter Chimney


Injection Port
Injection Port
35.90°
40'-11"
16'-0"
17'-3 1/2"
33'-3 1/2"
23'-5"
39'-5"
PIPE


7'-7 1/2"
7'-2 1/2"
55.22°
2'-2 1/2"
3 Injection Ports @ This Elevation
13'-5 1/2"
29'-5"


39'-5"
12'-0"
10'-11"
8'-0"
12'-0"
13'-5"
29'-5"
8'-0"
23'-5"
Injection Port
Injection Port
Injection Port

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Special Instructions	MC252 Incident		

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